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obtained from open-end interviews on which an analysis was performed utilizing a technique of behavioral research called semantic content analysis. The data analysis allowed for a determination of the relevent decision making factors and the subsequent recommendations on the development of a contract maintenance "decision tree" network. Basically, this "decision tree" would allow a manager to evaluate the options of contract maintenance versus organic maintenance, making a determination of which is optimal for the given situation. The factors identified by this research are considered to be "cost drivers" of the applicable maintenance options.

LSSR 7-77B

AN ASSESSMENT OF RELEVANT DECISION MAKING FACTORS FOR ORGANIC VERSUS CONTRACT MAINTENANCE OPTIONS ON USAF FLIGHT SIMULATORS

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements of the

Degree of Master of Science in Logistics Management

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MASTER OF SCIENCE IN LOGISTICS MANAGEMENT
(Major Ronald J. Arceneaux)

MASTER OF SCIENCE IN LOGISTICS MANAGEMENT (PROCUREMENT MAJOR)
(Captain George E. Farschman, Jr.)

DATE: 7 September 1977

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Chapter 1

INTRODUCTION

> The high cost of flying and a realization that the aircraft itself is probably the poorest classroom ever devised gave birth to a need for some kind of ground trainer as a substitute for the aircraft [3:10].

Thus, the predecessor of the modern day aircraft flight simulator was born. Over the years the value of flight simulators as a supplement to actual flight training has been increasing (2:2-10).

Since World War II flight simulators have progressed from simple cockpit training devices to highly sophisticated and computerized trainers. The advance of technology has changed simulator usage from training crew members in normal, emergency, and instrument procedures to training devices which are characterized by a myriad of realistic flight maneuvers and in-flight situations (23:42;25:4).

Until the last decade, though, simulation has not been given a great deal of publicity and emphasis. This situation has been reversed, however, by increasing costs, decreasing defense budgets, fuel shortages, and quantum jumps in simulator technology. These factors

have made it necessary to look in the direction of flight simulation for conservation of resources while successfully accomplishing the training mission (16:1). As the emphasis on simulator utilization increases, the maintenance of simulators will play a paramount role in their effectiveness.

Statement of the Problem

As the Chief of Staff of the Air Force (CSAF) stated before the Senate Committee on Appropriations for Fiscal Year (FY) 1977:

> The Air Force has found it necessary to make some rather drastic reductions in personnel and operating costs to insure adequate amounts of our limited resources would be available to accomplish the modernization of the Air Force which has been deferred for all too long [41:391].

Additionally, federal policy requires the Department of Defense (DoD) and other governmental agencies to rely upon the private sector of the economy for supplies and services (35:4). This policy does, however, have exception provisions which governmental agencies can exercise thereby precluding the use of the private sector for supplies and services under certain conditions. Office of Management and Budget (OMB) Circular A-76, provides the guidelines for determining whether a governmental

activity or agency will provide for the supplies or services in-house or contract out to the private sector of the economy (7:9).

The modernization and investment in flight simulators will be steadily increasing in the next few years (36:65). With emphasis on increased simulator usage, increasing investment costs, and continuing pressures to lower operating costs, contract maintenance for flight simulators at the organizational and intermediate levels in lieu of organic maintenance may have some merit (31:2;41:253). Assessment of factors relevant to using contract maintenance on flight simulators requires a taxonomy of the factors. A taxonomy of relevant factors will assist Air Force managers in addressing the issue of contracting out for maintenance or retaining an organic capability at the organizational and intermediate levels.

The problem is that a taxonomy of relevant factors does not exist for Air Force managers to use when confronted with the issue of contract maintenance versus organic maintenance.

Definition of Terms

Flight Simulator--A generic term which refers to a group of synthetic training devices that range from simple procedures trainers to high fidelity[1] devices; all are capable of simulating various aspects of flight [44:17].

The term aircrew training devices was considered synonomous with the term flight simulators.

Contract Maintenance-- . . . maintenance performed by a commercial organization under contract to USAF. Also, referred to as out-of-house maintenance, or "turn key" maintenance.

Organic Maintenance-- . . . maintenance performed by Air Force technicians who are either military or civil service personnel. Also, referred to as "blue-suit" or in-house maintenance.

Organizational Level Maintenance--The inspecting, servicing, lubricating, adjusting, and replacing of parts, minor assemblies and subassemblies by the using organization on its assigned equipment (42:1-1).

Intermediate Level Maintenance--The calibration repairing, or replacing of damaged or unserviceable parts, components, or assemblies, the modification of material, emergency manufacturing of unavailable parts by a designated maintenance activity for direct support of using organizations (42:1-1).

Abbreviations

A glossary of abbreviations used throughout this study is presented in Appendix A.

---

[1]Fidelity--"the exactness to which the simulator equipment duplicates the aircraft [19:10]."

Background

Events in recent years have increased the emphasis on the utilization of flight simulators as a substitute to actual aircraft proficiency training. The numerous advantages of simulator utilization which "fall in the broad categories of better training, improved safety practices, and monetary savings [19:1]" have become increasingly important due to the events that have affected, and policies that have been adopted by the Air Force in recent years.

Prior to 1970, the United States Air Force (USAF) expanded and modernized pilot training facilities in response to the requirements of the conflict in Southeast Asia. The cost to train a pilot escalated along with other costs in the economy. More complicated weapon systems required longer pilot training time. The CSAF indicated in 1970 that a critical examination of certain aspects of existing pilot training systems was needed to reduce the time and cost factors (25:1).

In 1971, the commercial airlines were training pilots by using what they referred to as the "Systems Approach to Training" which relied heavily upon simulators. The use of this approach brought about significant

cost savings. For example,

> The American Airlines Boeing 707 transition program in 1966 required an average of 18.3 aircraft hours per student captain. In 1971, after restructuring the training course, the average student captain required 3.1 aircraft and 15.0 simulator hours to complete transition [25:2].

This reduction in flying hours, coupled with estimates that it costs $2,800 per hour to fly a Boeing 707 for training and almost four times that to fly a Boeing 747, show significant savings (6:2). The achievements of the airlines in replacing aircraft training hours with simulator hours suggested possible application in USAF pilot training programs (25:2).

In 1973, the General Accounting Office (GAO) reviewed the pilot training programs of the Air Force and Navy to ascertain if greater use of simulators would reduce DoD costs without weakening pilot proficiency. The GAO pointed out the advancements that had been made in simulator technology and the fact that pilots could train in a successfully "simulated" flight environment without the cost and risk of actual flight. Additionally, the military services had not pursued improved simulators, in part due to the Southeast Asia conflict. As a result, emphasis had not been placed on the development and acquisition of the sophisticated simulators

which could satisfy more of the training requirements. The GAO mentioned studies completed by the Air Force and Navy in 1972 that predicted the flight time required at basic pilot training could be reduced by approximately 46 to 49 percent. The services felt that with better simulators and improved training techniques they could affect these savings by the mid-1980s depending upon the type aircraft involved. The GAO projected that if 25 to 50 percent of flight training in combat aircraft could be replaced by simulators, then a savings of $455 million to $910 million could be accrued annually (46:1-2).

Two other major points were made by the GAO. In another case of savings, the GAO recognized the need for flight simulators to ease the projected fuel shortages. Along with the cost and fuel savings, the safety aspect of the training environment was considered important. Pilots can train as much as is necessary in a simulator without the hazards of flight. This gives them an environment in which it is much more practical to practice emergency procedures without jeopardizing human life (46:2-3).

The GAO recommended that the Secretary of Defense require the Navy and Air Force to:

Put a higher priority on developing improved simulators which can replace maximum amounts of flight training.

Insure that development and use of adequate simulators are integral parts of acquisition or modification programs for sophisticated aircraft.

Use simulators as much as possible to reach and maintain desired proficiency, including the establishment of simulator grading methods which will provide a more accurate evaluation of pilot proficiency [48:3].

A great deal of emphasis on the flight simulator program was shown in 1975 when Brigidier General Norman C. Geddis, Special Assistant for Flight Simulation Matters to the CSAF, pointed out that within five subsequent years, investment in flight simulators was expected to exceed $1 billion. This investment includes the modification of existing A-7, C-5, C-141, FB-111, F-4E simulator models to incorporate a motion system and visual displays. Besides these modifications new advanced simulators for the B-52/KC-135 and C-130 aircraft are in the procurement process. Additionally, fuel costs had risen more than 300 percent in the previous two year period and DoD had decreed a 25 percent reduction in flying hours by 1981. Thus, the emphasis has been placed on developing sophisticated systems to act as a substitute for flying to replace outdated simulators

which had been designed as a <u>supplement</u> to flying (36:65; 43:11). With the development of these new systems, significant fuel savings have been projected for the future.

> For example, fuel savings of $444 million per year have been estimated for the B-52/KC-135/C-130 training programs when all the new simulators for these aircraft types have become fully operational [34:103].

"The sum of the factors is a continuing squeeze of defense dollars. Our option is to accomplish more with less, or, in a word, efficiency [23:45]." With these ever tightening constraints it is not surprising that the cost of flight training stands out. It is because of this that every effort must be made to improve the effectiveness and the efficiency of training operations (23:46).

A trend could be seen as early as FY 1972 in the decreasing nature of the purchasing power of the Defense Budget. Former Secretary of Defense Melvin R. Laird pointed this out in a statement concerning the FY 1972 budget.

> As with the Fiscal 1971 transitional budget, there is some risk attached to our FY 1972 Defense Budget for it continues the downward trend in over-all Defense Department purchasing power at a time when the threats we face around the world continue to increase, not diminish [45:7-8].

The following year he pointed out that:

> . . . total defense manpower is at the lowest level since 1950; dollar outlays for manpower have increased; and budget authority for manpower is being held roughly constant. The conclusion is unavoidable that we have fewer people to work with; they cost us more; and manpower funding is limited [23:45].

In May 1975, Ogden Air Logistics Center (ALC) was tasked by Headquarters Air Force Logistics Command (HQ AFLC) to conduct a study on the maintenance of training devices which included flight simulators. This study group was composed of personnel from Ogden ALC, Simulator Systems Program Office (SIMSPO), Air Training Command (ATC), Military Airlift Command (MAC), Tactical Air Command (TAC), Strategic Air Command (SAC), and selected major simulator manufacturers. This study ultimately provided many recommendations on methods to improve maintenance with inferences that simulators are a candidate for contract maintenance, especially at the organizational and intermediate maintenance levels (38).

One recommendation of the Ogden ALC study was that training devices should be managed as a separate logistics category and assigned a separate Budget Program Code. This recommendation was deemed necessary because neither cost/budget accounts were established nor were

procedures existing to record or project the costs associated with the logistics support of aircrew training devices (38:93,95). The Comptroller of the Air Force has since developed cost factors and a reporting system to record simulator support cost (28:5). The data on support costs are being gathered by the Comptroller's office; however, data are still lacking because of limited collection points to date (only FY75 and FY76 figures are available) (24;27).

The impact of continuing budget constraints was summarized in August 1975 by General Samuel C. Phillips with the following:

> Throughout the Air Force, tighter budgets and higher costs have forced commanders to seek better ways of managing their shrinking resources--ways that will enable them to get more efficiency and productivity from each dollar invested and each man-hour expended [29:2].

In January 1976, Lieutenant General John W. Roberts, Commander ATC, solicited support from HQ USAF/Logistics to pursue the idea of contract maintenance for USAF flight simulators. General Roberts cited ATC experience in contract maintenance at Vance and Sheppard Air Force Bases (AFB) and indicated that significant cost savings in logistical support could be realized (32). He further stated that:

An additional consideration is that personnel in the simulator training devices field do not contribute to USAF combat readiness. Although the overall number (approximately 2,000) is not large, it will assume increasing importance as pressure increases to reduce the size of military forces [32].

In an effort to seek better ways of managing Air Force resources, an innovative concept for flight simulator acquisition was introduced by Colonel Howard E. Wright, USAF, Director of the SIMSPO, in June 1976. The SIMSPO developed a logistics support option for inclusion in the acquisition phase of a new instrument flight simulator for the C-130 aircraft. This concept has subsequently taken on the name the "White Paper on Flight Simulator Support." (Appendix B) This paper stressed the importance of structuring the logistics support part of the contract in such a manner that the contractor would design the simulator with improved reliability and maintainability because he would be responsible for the availability of the simulator for training. The approach features a design for support philosophy and contractor performance would be judged on an annual basis with recurring options for another yearly increment. A period of four years is what the SIMSPO proposed for contract support. After this four year period the Air Force could elect to do

the maintenance organically or renew the contractor's option (28).

The advantage of such a concept would be that, hopefully, it motivates a contractor to design and build more reliable simulators along with greater ease of supportability and improved maintainability. If the contractor is graded on the simulator's availability for training, then a reduction in maintenance time is a definite plus for the contractor (28).

This type of contract maintenance support option helps avoid situations where the Air Force initially trains maintenance technicians for a new flight simulator and then non-utilization of these personnel occurs because of production slippage and program changes. A learning curve is also associated with bringing in any new system and the contractor should be in a better position to handle contingencies as they occur. The contractor can also provide a back-up spares support system and not be totally dependent upon the Air Force supply system for support; thus, some downtime waiting for supply support is eliminated. Another feature of this approach is that the contractor finds his compensation affected in a major way by the same thing the Air

Force is interested in, availability and reduced support cost (28). Colonel Wright described this technique as "bringing reliability improvement warranties into the simulator world [34:101]."

The present maintenance concept for simulators consists of three levels (organizational, intermediate, and depot) with organizational and intermediate level maintenance performed by the using commands. If the maintenance requirements on a particular flight simulator exceed the base's organic maintenance capability, the base may procure Contract Engineering Services (CETS) in accordance with Air Force Manual 66-18, Engineering and Technical Services Management and Control. Depot level maintenance is not normally accomplished on site although AFLC has provided between 60 and 75 contract depot level maintenance technicians to provide on-location maintenance if requested by a particular base (38:94). The overall management for simulator support is assigned to Ogden ALC, chartered to maintain configuration of training devices compatible with the associated aircraft and provide logistics support for aircrew training devices maintained by government personnel (40:143).

For the modern advanced flight simulators under acquisition, the Air Staff has directed that HQ AFLC establish the maintenance concept as early in the development or production phase as possible to permit proper logistics planning, such as initial spares provisioning, technical data acquisition, and formal training requirements. The establishment of the maintenance concept will be accomplished on a case-by-case basis by HQ AFLC in coordination with AFLC, ATC, and the using command (37).

With substantial monies being invested in flight simulators, maintenance will play a paramount role in their effective utilization. In the past, Air Force crew members had an attitude barrier to overcome in the use of older simulators because of equipment design limitations; now a new attitude barrier can develop if simulator maintenance fails to keep pace with the increasing operational requirements. Maintenance on flight simulators is considered critical to the success of Air Force simulator efforts (43:11).

__Justification__

As emphasis in simulator usage increases, the support (maintenance) requirements and resource

allocations will have to keep pace with increased usage. A central theme in today's DoD is to lower Operation and Support (O&S) costs since expenditures required to support established systems are taking larger shares of the defense budget (31:2). Maintaining flight simulators either by contract or organic maintenance should be evaluated to help achieve this end.

The OMB Circular A-76 dated 30 August 1967 and recently revised 18 October 1976

> . . . expresses the Government's general policy of relying upon the private enterprise system to supply its needs for products and services, in preference to engaging in commercial or industrial activities [13:1].

While the intention of Circular A-76 is to prevent the government from competing with industry, provisions for exceptions exist (35:4). The exceptions are:

> Procurement of a product or service from a commercial source would disrupt or delay an agency's program.
>
> The government must operate an industrial activity for purposes of combat support, for retraining of military personnel, or to maintain or strengthen mobilization readiness.
>
> A satisfactory commercial source is not available and cannot be developed in time to provide a product or service when it is needed.
>
> The product or service is available from another Federal agency.

Procurement of a product or service from a commercial source will result in a higher cost to the government [12].

Circular A-76 in essence requires that if one of the first four major exceptions do not apply, then the particular agency performs a cost comparison of alternatives available before determining if the service or good is to be accomplished organically or contracted out to the private sector. Prior to the 1976 revision of Circular A-76 the exception to the policy used frequently by the services which has precluded the utilization of contractual services in accordance with Circular A-76 was that cost studies indicated that supplies and services could be provided by the government at a lesser cost (10:9).

The proposed new Air Force Logistics Doctrine also emphasizes the national policy of reliance on the private sector for supplies and services. The doctrine also provides specific instances where it is in the best interest of the government to provide the supplies and services from within. These instances were in consonance with the major exception provisions of Circular A-76 previously mentioned (33).

The 1976 revision to Circular A-76, which included an increase in the Civil Service retirement cost factors, may have a significant impact upon future decisions regarding utilization of the private sector. The cost factors which increased from 7 to 24.7 percent of base pay could possibly tip the balance in favor of the private sector in cost comparisons between utilization of contractor versus organic maintenance (7:A-23).

Recent GAO inquiries into contracting-out has put political leverage on DoD to take an in-depth look at utilizing the private sector to a greater extent. These inquiries were directed toward the areas of real property maintenance, custodial services and food services which could easily be considered as non-military essential support activities (17). While the maintenance of flight simulators may or may not fit into the same category, it is necessary to address the issue with the increasing interest in contracting-out that is present in the federal government.

Since the revision of Circular A-76, AFLC has considered several base activities as candidates for contracting-out. Base support functions, civil engineering, certain motor pool functions, audio-visual

services, and precision measurement equipment laboratory (PMEL) function for six command sites are under consideration (8). AFM 26-1, Manpower Policies and Procedures, studies are being performed in the above mentioned areas for the purpose of "increasing the use of private contractors to provide non-military essential services in compliance with Circular A-76."[1]

In deciding whether to contract for maintenance or not, more than just the economics of the situation are involved. Simulators are known to have a high manpower cost of ownership function (27). This manpower cost would immediately make simulators attractive as a candidate for contract maintenance, especially when the new manpower cost figures contained in Circular A-76 are used in making a cost comparison in accordance with Air Force Manual 26-1.

The initial direction of this research effort was of a cost comparison between flight simulators maintained organically versus those maintained contractually at the organizational and intermediate maintenance level. While this approach appeared feasible at the beginning, several obstacles arose which caused the research effort to take a new direction. The obstacles basically stemmed from

three sources; the inability to accurately identify the cost of maintenance on a flight simulator, limited selection of simulator devices which are maintained both organically and contractually, and major command parochialism stemming from rationale of retention of organic resources versus utilization of contract services.

At present, inroads in the accumulation of cost data on flight simulators are being made at HQ USAF. The categories for which cost figures are available for aircrew training devices are manpower, equipment, supplies, utilities, and temporary duty (TDY) costs. The collection of these data comes from the operating locations via major command simulator managers to the Comptroller's office. Cost figures are available for FY75 and 76, however, some uncertainties are prevalent as to what should and should not be included as a cost within a specific category (24).

The Air Force experience with contract maintenance on flight simulators has been limited to some unique sophisticated simulators in TAC, not representative of those found at other operational units, and selected trainers in ATC. TAC maintains the Simulator for Air-to-Air Combat (SAAC) at Luke AFB, Arizona under

a contract maintenance agreement (30). This unique simulator is used for operational training and as an evaluation device for research and development for which it was originally designed and procured (30;36:68). Prior to October 1976, TAC also had under maintenance contract F-4E Simulator #18, which was used for operational evaluation of the visual and motion systems, and was only partially representative of a F-4E simulator. Examples of F-4E #18's uniqueness are six-degree motion base, digital radar land mass, and camera model board for visual display, which are all "one of a kind." This simulator was declared excess to TAC requirements and placed in storage in October 1976 (30;40:45).

ATC presently has the Instrument Flight Trainers for the T-37 and T-38 aircraft at Vance and Sheppard AFBs under contract maintenance. These trainers, however, were only placed under contract during the October-November 1976 time period and hence data for a cost comparison of actual maintenance expenditures with another undergraduate pilot training base in ATC would have been very limited. ATC did provide a sample resource management system report on Webb AFB aircrew training device cost center and indicated a willingness

to provide additional reports if needed (21). Since the figures for operation under the contract made were less than one year, the cost comparison approach was deemed infeasible to pursue for this research effort, but does have potential for a future research endeavor.

The initial research effort began soon after the "White Paper on Flight Simulator Support" was forwarded to the major commands for comment (11). The logistics support option provided in this paper generated parochialism as to what type of maintenance option best met the command needs. While representatives from ATC, MAC, SAC, and TAC were willing to discuss the contractual issue, the responses became opinionated on the use of contractual services and all were unanimous that trying to determine the actual cost of maintenance would be a monumental task at the present time and provided no encouragement (9;18; 21;30).

The conclusion reached on the initial research effort was that the issue of utilizing contractual services versus retaining organic capability was viable and politically sensitive and that the methods of obtaining cost data on aircrew training devices needed to mature before making a cost comparison.

While cost will continue to be a key factor in determining whether to contract for maintenance or not, a more reasonable assessment, due to limitations in the cost accounting, could be made assuming a series of relevant decision factors existed and could be made available to Air Force managers. Relevant factors would consist of those areas which would have a significant impact upon the decision to contract for maintenance or maintain an organic capability. If this assumption is true, then these relevant factors will possibly direct Air Force managers' attention into the areas of retention of Air Force skills to meet surge requirements, technical complexity of the simulators in active inventory, and current manpower authorizations (ceiling limitations). The acknowledgment of other areas will enable tradeoffs between costs and these relevant factors and possibly provide a more definitive method of decision making.

The Directorate of Plans and Industrial Resources, HQ AFLC uses a "decision tree" network to determine whether maintenance capability is retained in-house or contracted out for depot maintenance wartime requirements. The "decision tree" network considers relevant factors such as surge workload requirements,

workload priorities, availability of contractual sources at reasonable cost and obstacles to an organic capability (Figure 7, Appendix C). Acknowledgment of these factors allows tradeoffs to occur and not place cost as the single criterion for utilizing contract services or not. The key ingredient that the directorate uses in the "decision tree" is the present in-being resources that can be expanded to meet the wartime requirements (39).

Since AFLC makes effective use of a "decision tree" network to determine whether depot maintenance is retained in-house or contracted out, a similar "decision tree" could possibly be of value to maintenance managers addressing maintenance options on flight simulators at the organizational and intermediate level. Therefore, this necessitates the identification of relevant factors so that a realistic assessment of contract maintenance versus organic maintenance of Air Force flight simulators at the organizational and intermediate level can be made in the best interest of the Air Force.

Scope

The determination of relevant factors in the thesis effort was limited to contract maintenance versus

organic maintenance of Air Force flight simulators at the organizational and intermediate level. The interim contractor support associated with new simulator deployment was not considered in the determination of relevant factors. While acknowledgment is made of the U.S. Army and Navy's contract simulator maintenance programs, they were not considered within the scope of this research effort.

Research Objective

The objective of the research was to identify relevant factors which Air Force managers should consider when addressing the issue of whether to contract for maintenance or utilize organic maintenance on Air Force flight simulators.

Research Question

What are relevant factors which an Air Force manager should address concerning the issue of contracting for maintenance versus utilizing organic maintenance on Air Force flight simulators?

Chapter 2

METHODOLOGY

Overview

The objective of this research was to identify relevant factors which should be addressed in the decision of whether or not to contract for the maintenance of flight simulators. To accomplish the objective, analyses of available correspondence and open end interviews were made. The methodology with which the factors were determined is semantic content analysis. The design of the content analysis model and the procedures to be utilized in the reliability testing and implementation of the model will be presented in this chapter. The use of a research study conducted by Coslett and Leedle was found to be an excellent guide to the development of a methodological approach (22).

Universe

The universe consists of all correspondence and personnel dealing directly or indirectly with maintenance of simulation devices in the USAF. This includes personnel at all levels, from the system operators through the higher levels of management to the Air Staff.

Population

Within the universe of simulation devices, the primary concern of this research was with flight simulation devices. Therefore, the population of the proposed research was correspondence and personnel dealing directly or indirectly with the maintenance of flight simulators in the USAF. As was the case in the universe, this includes personnel at all levels in the USAF chain-of-command.

Data Collection and Sampling Plan

The data producing sample was a sample of convenience of key personnel dealing directly or indirectly with maintenance of flight simulators. The personnel were selected based upon their organizational position and location of assignment. Personnel were interviewed who occupied the following positions:

- Deputy Commander for Maintenance (DCM)
- Maintenance Supervisor of Avionics Maintenance Squadron (AMS)
- Branch Chief of the Aircrew Training Devices (ATD) Branch
- Shop/Shift Chiefs concerned with the actual maintenance of flight simulators.

Eight bases were sampled, two flight simulator operating

locations from each of four major commands (SAC, TAC, MAC, ATC). A schedule of the bases actually visited to obtain the data for this research effort can be found in Appendix D.

Additionally, the sample included the members of the Simulator Advisory Group (SAG) which convened on 26 April 1977 at Wright-Patterson AFB, Ohio. The SAG was chosen because the members represented the management structure not involved with the day-to-day simulator operations but with simulator development, acquisition and support. This is indicated by the SAG's two basic functions:

> Periodically review Air Force aircrew simulator programs for effectiveness and efficiency and to promote timely definition and integration of research, technology, engineering, acquisition, and logistics support.
>
> Provide a focal point within the Air Force for maintaining a continuing interface with the Navy and other organizations involved in simulation technology and hardware development. The purpose of this activity [is to] ensure an aggressive and timely interchange of information in technology, acquisitions, programs, operational experience, and methods and procedures for simulator development, acquisition and support [40:138].

The SAG is composed of representatives from the Air Staff, Special Operating Agencies, AFLC, AFSC and major commands (26).

The data were collected by conducting an open-end interview with each individual in the sample. The interviews were conducted utilizing the instrument/question in Appendix E. All available literature was utilized in performing the pilot study (Appendix G) and as a result the same literature was not utilized in order to answer the research question.

Data Analysis Plan

Content analysis was decided upon as a methodology capable of assisting in the determination of relevant factors for the utilization of contract maintenance for flight simulators.

> Content analysis is a research technique for the objective, systematic, and quantitative description of the manifest content of communication [3:18].

The first uses of content analysis were by students of journalism in the study of the content of newspapers. The technique consisted of counting the number of times a key word or phrase appeared (4:22).

> In recent years, the technique has been used in increasingly varied settings and for a wide variety of research purposes [15:646].

Content analysis "can be applied to available materials or to materials especially produced for particular

research problems (20:527)." Some of the items to which content analysis can be applied are letters, periodicals, minutes of meetings, and newspapers (20:528). Additionally, methodological techniques such as open-end questions with either verbal or written responses may be analyzed with the content analysis technique (15:646).

There are two levels involved in content analysis, manifest and latent. In the manifest level of content analysis what the respondents actually said, with nothing read into it, is coded. On the other hand, in content analysis at the latent level the researcher attempts to code the meaning or what appears to be implied by the response. Evidence indicates that content analysis at the manifest level can be performed reliably. This cannot be said of analysis at the latent level due to the possible variance in interpretations of the "meaning" behind the response (15:647-8). Therefore, content analysis at the manifest level was utilized for this research. This allowed for greater validity and improved reliability in the findings of the research.

There are three basic methods of performing content analysis: semantic content analysis, content analysis for feeling tone, and content analysis of intent (15:647).

> A semantic content analysis involves the development of a set of categories intended to represent the dimensions and specifics of the actual content of the responses [15:656].

Semantic content analysis was utilized in the research effort, only coding what is actually said or written. In this research the analysis was accomplished on responses to the open-end interviews.

The other two basic methods, content analysis for feeling tone and content analysis of intent were not considered appropriate. Content analysis for feeling tone attempts to abstract a sense of tone or attitude being communicated by the response. Use of this method requires a positive or negative valence attached to the meaning of the "content unit" which was not the intent of this research. Content analysis of intent is used in the latent level whereby the researcher is interested in what the response implies or infers rather than what is explicitly said (15:649-68).

Prior to categorizing specific units, a distinction between the recording unit and context unit needed to be made. The recording unit is defined as "the smallest body of content in which the appearence of a reference is conducted [4:135]." In this research the

recording unit was the "word." This is generally the smallest recording unit utilized in content analysis. This type recording unit includes phrases as well as single words (4:136). The context unit is defined as "the largest body of content that may be examined in characterizing a recording unit [4:135]." In this research effort the context unit was the "paragraph."

Once the method and level of content analysis had been decided, the set of categories and method of recording observations were developed. The subject-matter categories, which are a nominal level of measurement, permitted the frequency calculation of data assigned to them (5:31-2). Content analysis is

> . . . based on the placement of responses or fragments of responses in categories developed in the context of the research purpose [15:675].

The categories were selected so that they fulfilled three requirements. First, the categories met the needs of the study so that the questions asked were answered. Secondly, they were mutually exclusive. Finally, the categories were collectively exhaustive in relation to the problem (5:39). In developing categories there are two levels to consider; general and specific. The general level was used to define an overall category or area and

within this level the specific level or subcategories were defined (15:657). Once the categories and subcategories were identified, the establishment of the general coding scheme was accomplished. The coding scheme developed is shown in Figure 1.

First, the general area category of "contract" is defined as to the immediate ramifications, either pro or con, of being in a situation in which contract maintenance is employed on the flight simulator maintenance system in general terms due to entering into a contractual agreement. The subcategories which were coded under the contract category are described as follows:

1. Cost--the cost of utilizing contract as opposed to organic maintenance for flight simulators, in general terms such as alluding to the cost effectiveness of either method.

2. Flexibility--general constraints placed on or removed from the operation or maintenance of flight simulators due to contractual procedures. This category included such areas as union activities, strikes, and the necessity to renegotiate contractual arrangements with each increase or decrease in the scope of activity.

GENERAL AREA	SPECIFIC AREA
First Digit	Second Digit
(1) Contract	(1) Cost (2) Flexibility (3) Skills (4) Other
(2) Simulator Operations	(1) Availability (2) Facility Upkeep (3) Schedule Flexibility (4) Support Equipment (5) Configuration Control (6) Technical Data (7) Other
(3) Manpower	(1) Cost (2) Acquisition of Personnel (3) Formal Training (4) Turnover of Personnel (5) Mobilization (6) Flexibility (7) Other
(4) Supplies	(1) Responsibility (2) Pipeline Flow (3) Cost (4) Other

Figure 1

Code for Semantic Content Analysis of Relevant Factors

Additionally, the responsibility for and problems with control of the contractor were coded in this category.

3. Skills—the unique system knowledge built up and retained by the contracting party during periods of contract maintenance and/or the impact of contractor withdrawal. This category was utilized when reference was made to the loss of Air Force maintenance technicians and the possible impact on future capabilities due to the utilization of contract maintenance. Additionally, this category was utilized in reference to the required skill level needed to maintain the system.

4. Other—utilized when one of the specific subcategories did not apply.

The second area category "Simulator Operations" is defined as the impact on the flight simulator system itself as a result of utilizing organic maintenance or contracting for the maintenance. This included the overall facilities, maintenance, operation, and equipment requirements. The subcategories were established and coded as follows:

1. Availability—utilized when the quality of the system was addressed in terms relating directly or indirectly to the system availability. This included

references to areas directly related, such as reliability, maintainability, and the supportability of flight simulators in conjunction with contract or organic maintenance options. The timeliness of response by maintenance personnel which directly affects system availability was addressed in this subcategory.

2. Facility Upkeep—was coded whenever reference was made to the questions of responsibility for facility upkeep or how the facility upkeep would be accomplished in either the organic or contract maintenance mode.

3. Schedule Flexibility—the impact of contract or organic maintenance on the ease of scheduling flight simulators for training purposes. This subcategory was utilized whenever questions or problems were brought up dealing with the flexibility of simulator use or the control over simulator utilization as a result of the applicable maintenance option.

4. Support Equipment—was utilized whenever reference was made to who whould have to provide support and/or special test equipment for the maintenance of the flight simulators. This category also included any problems associated with the support and test equipment because of the particular maintenance option chosen.

5. Configuration Control—was coded whenever the effectiveness of configuration control was addressed with regard to either organic or contract maintenance. This category dealt primarily with the success of maintaining high "fidelity" under the applicable maintenance concept.

6. Technical Data—was deemed appropriate whenever reference was made to technical data in conjunction with a particular maintenance option. This category included responsibility for, problems with, and the impact of maintenance options on technical data.

7. Other—was coded whenever reference was made to the general category of simulator operations in conjunction with organic or contract maintenance and it could not be coded into one of the specific subcategories.

The third area category was broken out as "Manpower." It is defined as all matters impacting on manpower and manpower requirements in relation to the decision to contract for maintenance or to employ organic maintenance. The specific subcategories were established and coded as follows:

1. Cost—the financial implications of manpower addressed in relation to the decision of whether or not to contract for maintenance or employ organic maintenance.

This category was not utilized whenever the cost of formal training was addressed as it was not considered as a manpower cost per se but rather categorized under a different subcategory.

2. Acquisition of Personnel--was utilized whenever anticipated or actual problems with the recruitment of personnel for either organic maintenance or contract maintenance was addressed resulting from or impacting on the decision to utilize contract or organic maintenance. References to military manpower ceilings were also coded in this category.

3. Formal Training--used whenever the addition or deletion of formal training such as technical schools was addressed in relation to the decision to contract for or utilize organic maintenance. This category was also utilized for possible problem areas the contractor may face in the area of formalized training requirements.

4. Turnover of Personnel--the turnover of Air Force or contractor maintenance personnel addressed in relation to the quality of maintenance, informal training problems, or impacting on the decision of whether or not to contract for maintenance.

5. Mobilization--Air Force contingency requirements for personnel, linked to requirements for or restrictions against the use of simulator maintenance personnel. Surge requirements for wartime contingencies were also coded in this category.

6. Flexibility--the flexibility of manpower utilization during normal operations addressed in relation to the contract or organic maintenance options.

7. Other--was coded whenever reference was made to the general category of manpower and proper categorization could not be made in one of the subcategories.

The fourth general area category of "Supplies" is defined as the responsibilities and impact of the Air Force or contractor's supply system on the decision whether or not to contract for maintenance. Supplies consist of those materials and spare parts necessary to maintain the flight simulators in operational condition. The specific subcategories were outlined and coded as follows:

1. Responsibility--was utilized whenever reference was made to the responsible agent, Air Force or contractor, who provided the necessary supplies to maintain the flight simulators and the impact of utilizing

their system on the decision of whether or not to contract out for maintenance.

2. Pipeline Flow--the impact of supply pipeline flow problems on the contract to maintain flight simulators and the further impact on the decision of whether or not to contract for maintenance.

3. Cost--was coded whenever reference was made to the cost of supplies under the contract or organic maintenance option.

4. Other--appropriate whenever reference was made to the general category of supplies and proper categorization could not be made in one of the subcategories.

<u>Pilot Study</u>

To insure proper categorization had been performed and reliable coding could be accomplished, a pilot study was deemed necessary for the proposed research. For the pilot study, a judgmental sample consisting of all existing Air Force correspondence and literature that had been collected concerning the maintenance of flight simulators was selected. The sample consisted of letters, minutes, staff summary sheets, command items of interest,

messages, and studies. A listing of all documents utilized is contained in Appendix F.

It was essential to estimate the effective utilization of the coding scheme. To ascertain the reliability with which each coder could use the code, the percentage of agreement between two independent coders was calculated. To insure adequate reliability, at least 90 percent agreement was necessary between the coders, utilizing a two-digit code (15:669). To calculate the percentage of agreement the following formula was utilized (15:669):

$$\text{Percent agreement} = 100 \times \frac{\text{Number of identical codings}}{\text{Total number of codings}}$$

The first trial, which showed only a 75 percent coder reliability, indicated a need for adjustments in the categorizations and a great deal of practice for the coders. After several trials and adjustments, the coders became much more adept at coding the material and the categorization problems were smoothed out.

In the pilot study there were a total of 134 units of data coded. Of this, 124 of the units of data were coded the same by the coders. Thus, the coder reliability finally obtained after modifying the categories and adequate coding practice was 92.54 percent. This

reliability figure met the criterion expected for two-digit coding.

The frequency calculations of categories and subcategories were accomplished manually for the pilot study. The results of the pilot study are found in Appendix G.

Criteria Tests

Determination of relevant factors of consideration in deciding whether or not to contract for maintenance requires the establishment of criteria tests. Criteria tests were utilized to establish bounds and limits in the determination of which factors would be considered relevant. The first criterion, concerning general area categories, was that any category with more than five percent of the total data coded was considered a significant and relevant factor. The second criterion to be established concerned the subcategories of "Other." An analysis was first made on the items included within the category and if a specific item was repeated, a new subcategory was established within the respective general category. The third criterion, concerning the specific level subcategories, also considered any subcategory with more than five percent of the general category data coded

as significant. This criterion was applied after all iterations were complete to insure that no subcategories were absorbed into the "Other" subcategory unnecessarily. A fourth criterion was necessary within the general areas. If a significant specific level subcategory contained more than 25 percent of the data coded for a significant general area category, then that specific level subcategory was extracted from that general area category. Then a new general area category was established by the old specific level subcategory. The one exception to this was the subcategory of "Other." It was not deemed appropriate to break this area out as a general category of its own since it was not considered as separately identifiable from its respective general area. Once this was accomplished, a reevaluation took place to ascertain which categories were to be considered significant (22:41-2).

Chapter 3

DATA ANALYSIS AND FINDINGS

Overview

The objective of this research was to determine those factors which should be considered by Air Force managers in making the decision of whether or not to utilize contractual services for flight simulator maintenance. As described in Chapter 2, the method selected for determining these factors was semantic content analysis. This chapter, utilizing the results of the open-end interviews and the criteria tests, breaks out the relevant factors for possible use in making trade-offs in decision making situations.

Once the data were coded using the proper categorizations, an iterative process was manually performed to finally arrive at those categories which appeared most relevant. This chapter describes in detail the iterative process performed to finally arrive at the relevant decision making factors. For ease of reference a synopsis of criteria tests developed in Chapter 2 and used for the data analysis is shown in Figure 2.

Test Number	Criteria
1	General categories . . . to be significant a general area must have had at least five percent of the total data coded.
2	Subcategory "Other" . . . if two or more specific items were coded in "Other" a new subcategory within the general area was established.
3	Subcategories . . . for any subcategory to be significant it must have contained at least five percent of the data coded within the general area (applied after final iteration only).
4	New general category . . . a new general category was established if a specific subcategory had 25 percent of the data coded within a general area with exception of subcategory "Other."

Figure 2

Synopsis of Criteria Tests

Analysis

The data-producing sample, as discussed in Chapter 2 and shown in Appendix D, provided a total 54 open-end interviews. From these 54 interviews a total of 337 categorizations were made. The initial results obtained

from the coded data are shown by general category in Table 1. As shown, all four initial general categories in Table 1 met the five percent criterion test for significance (criterion test 1). Next, a detailed look at the "Other" subcategories indicated that a further breakout was necessary in accordance with criterion test 2.

Table 1

General Category Relative Frequency Distribution (Initial)

General Category	Absolute Frequency	Relative Frequency (Percent)
Contract	126	37.39
Simulator Operations	107	31.75
Manpower	79	23.44
Supplies	25	7.42
Total	337	100.00

Within the "Contract Other" category three data items were found to be repeating thus qualifying them for a specific subcategory breakout in accordance with the second criterion test. The first new subcategory

labeled "Award" consisted of a total of five data items. The "Award" subcategory concerns the bidding and contract award procedures currently in effect. Specifically, this category is concerned with the fact that the lowest responsive and responsible bidder under a competitive procurement will receive the bid normally and concern existed in relation to possible shortcuts in an effort to reduce costs. The second new subcategory labeled "Budgeting" consisted of a total of four data items. The "Budgeting" subcategory relates to the problem inherent in the annual appropriation of money within the DoD. The subcategory is concerned with possible problems in obtaining funds for contractual services on a year-to-year basis as the political climate varies. The final new subcategory within the "Contract" general category is labeled "Contractor Capability." This subcategory consisted of two data items. The "Contractors Capability" subcategory is concerned with the overall financial and technical capabilities of a contracting firm to perform the required services in the manner dictated by mission requirements.

The next general category to have added specific subcategories was "Simulator Operations." Analysis of

the "Other" subcategory indicated that a total of five new subcategories were required. The first new subcategory was labeled "Security." This subcategory consisted of a total of four data items. The category is defined as the impact on simulator operations or problems encountered because of security. Security here was in reference to classified material as opposed to physical security. The second new subcategory "Quality Control" consisted of a total of two data items. "Quality Control" is concerned with having an adequate quality control program to insure quality maintenance under the contract maintenance option. The third addition to the "Simulator Operations" category was "System Complexity." This specific subcategory consisted of a total of five data items. "System Complexity" deals with the effect on the contract maintenance decision due to the results of an analysis of the complexity of the applicable simulator system. The fourth subcategory that was added, "Operators," consisted of a total of three data items. This subcategory was in reference to who would be responsible for operating the flight simulators under the contract option. Under current operating procedures, occasionally the same Air Force technician who is

responsible for maintaining the simulator also serves as an operator. It was under this type of situation when the question of who would operate the system that "Operators" was deemed appropriate. The final subcategory that was added was labeled "Operating Environment." This subcategory consisted of a total of three data items. The concern of this area is with the non-combatant nature of flight simulators and the effect this fact has upon the decision of whether or not to contract for maintenance.

The final general category to have a subcategory added was "Manpower." An analysis of the "Other" subcategory indicated that one subcategory needed to be added. The new, subcategory was labeled "Overseas Imbalance." This category consisted of a total of four data items. This subcategory is concerned with the problems inherent in operating simulators located at overseas locations if most or all of the Conus flight simulators are under the contract option. Either Air Force simulator technicians would operate mostly at overseas locations or these overseas locations would also have to be placed under the contract option. The subcategories after completion of the second criterion test are shown in Table 2.

Table 2

Subcategory Relative Frequency Distribution
(Initial)

General Category	Subcategory	Absolute Frequency	Relative Frequency (Percent)
Contract	Cost	39	30.95
	Flexibility	40	31.75
	Skills	29	23.02
	Award	5	3.97
	Budgeting	4	3.17
	Contractor Capability	2	1.59
	Other	7	5.55
Total		126	100.00
Simulator Operations	Availability	38	35.52
	Facility Upkeep	6	5.61
	Schedule Flexibility	24	22.43
	Support Equipment	3	2.80
	Configuration Control	8	7.48
	Technical Data	7	6.54
	Security	4	3.74
	Quality Control	2	1.87
	System Complexity	5	4.67
	Operators	3	2.80
	Operating Environment	3	2.80
	Other	4	3.74
Total		107	100.00

Table 2 (continued)

General Category	Subcategory	Absolute Frequency	Relative Frequency (Percent)
Contract	Cost	6	7.59
	Acquisition of Personnel	22	27.85
	Formal Training	16	20.25
	Turnover of Personnel	15	18.99
	Mobilization	3	3.80
	Flexibility	10	12.66
	Overseas Imbalance	4	5.06
	Other	3	3.80
Total		79	100.00
Supplies	Responsibility	11	44.00
	Pipeline Flow	8	32.00
	Cost	4	16.00
	Other	2	8.00
Total		25	100.00
Grand Total		337	100.00

As shown in Table 2 "Contract Cost," "Contract Flexibility," "Simulator Availability," "Acquisition of Personnel," "Supply Responsibility," and "Pipeline Flow" all met the criterion of greater than 25 percent of a significant general category (criterion test 4). Additionally, several of the subcategories failed to meet the five percent criterion for data coded within a general category. These subcategories were retained intact since criterion test three would be performed after the last iteration. As a result of applying criterion test 4 a second iteration was performed with the new general category breakout of:

Contract	Manpower
Contract Cost	Acquisition of Personnel
Contract Felxibility	Supplies
Simulator Operations	Supply Responsibility
Simulator Availability	Pipeline Flow

The second iteration of the general category relative frequency distribution is presented in Table 3.

The new general category breakout as shown in Table 3 shows an increase from four general categories to ten general categories. This situation was temporary, however, due to three categories failing to meet the five percent significance of criterion test 1. The categories of "Supplies," "Supply Responsibility," and

Table 3

General Category Relative Frequency Distribution
(2nd Iteration)

General Category	Absolute Frequency	Relative Frequency (Percent)
Contract	47	13.95
Contract Cost	39	11.57
Contract Flexibility	40	11.87
Simulator Operations	69	20.48
Simulator Availability	38	11.28
Manpower	57	16.91
Acquisition of Personnel	22	6.53
Supplies	6	1.78
Supply Responsibility	11	3.26
Pipeline Flow	8	2.37
Total	337	100.00

"Pipeline Flow" were all regrouped into the original general category "Supplies" which again met the five percent significance criterion. Once the regrouping was accomplished, the second iteration of the subcategory relative frequency distribution was accomplished and is shown in Table 4. The application of criterion test 4 again indicated that a further breaking out of new general categories was necessary. The subcategories of "Contract Skills," "Schedule Flexibility," "Formal Training," and "Turnover of Personnel" all exceeded 25 percent of their general category. Additionally, the subcategories of "Supply Responsibility" and "Pipeline Flow" met the 25 percent criterion test but since they failed to previously meet the five percent significance test for a general category no change was made to the "Supplies" general category and subcategories.

After completing the criteria tests in the second iteration a total of 12 general categories remained. The additions to the general categories for the third iteration were: "Skills," "Schedule Flexibility," "Formal Training" and "Turnover of Personnel." The general category relative frequency distribution

Table 4

Subcategory Relative Frequency Distribution
(2nd Iteration)

General Category	Subcategory	Absolute Frequency	Relative Frequency (Percent)
Contract	Skills	29	61.70
	Award	5	10.64
	Budgeting	4	8.51
	Contractor Capability	2	4.26
	Other	7	14.89
Total		47	100.00
Contract Cost		39	100.00
Total		39	100.00
Contract Flexibility		40	100.00
Total		40	100.00
Simulator Operations	Facility Upkeep	6	8.69
	Schedule Flexibility	24	34.78
	Support Equipment	3	4.35
	Configuration Control	8	11.59
	Technical Data	7	10.14

Table 4 (Continued)

General Category	Subcategory	Absolute Frequency	Relative Frequency (Percent)
	Security	4	5.80
	Quality Control	2	2.90
	System Complexity	5	7.25
	Operators	3	4.35
	Operating Environment	3	4.35
	Other	4	5.80
Total		69	100.00
Simulator Availability		38	100.00
Total		38	100.00
Manpower	Cost	6	10.53
	Formal Training	16	28.07
	Turnover of Personnel	15	26.32
	Mobilization	3	5.26
	Flexibility	10	17.54
	Overseas Imbalance	4	7.02
	Other	3	5.26
Total		57	100.00

Table 4 (Continued)

General Category	Subcategory	Absolute Frequency	Relative Frequency (Percent)
Acquisition of Personnel		22	100.00
Total		22	100.00
Supplies	Responsibility	11	44.00
	Pipeline Flow	8	32.00
	Cost	4	16.00
	Other	2	8.00
		25	100.00
Grand Total		337	100.00

for the third iteration is shown in Table 5. Evaluation of these general categories showed that "Formal Training" and "Turnover of Personnel" did not meet the five percent test for significance for a general category (criterion test 1) and were regrouped under the general category of "Manpower," retaining their identity as a subcategory. A third iteration on the relative frequency distribution was then accomplished and is presented in Table 6.

The specific subcategories as depicted in Table 6 were evaluated utilizing the 25 percent of general category (criterion test 4). In this iteration only two subcategories not previously tested exceeded 25 percent of their respective general category. The first was "Award" which was broken out as a general category. The second one was "Contract Other" which was not broken out as a separate category in accordance with the fourth criterion test concerning "Other" subcategories.

The revised list of general categories is presented in Table 7. The revised set of general categories contained 11 general categories with the one addition of "Award." This new category did not prove to be significant under the five percent of total data items criterion

Table 5

General Category Relative Frequency Distribution
(3rd Iteration)

General Category	Absolute Frequency	Relative Frequency (Percent)
Contract	18	5.34
Contract Cost	39	11.57
Contract Flexibility	40	11.87
Skills	29	8.61
Simulator Operations	45	13.35
Schedule Flexibility	24	7.12
Simulator Availability	38	11.28
Manpower	26	7.71
Formal Training	16	4.75
Turnover of Personnel	15	4.45
Acquisition of Personnel	22	6.53
Supplies	25	7.42
Total	337	100.00

Table 6

Subcategory Relative Frequency Distribution
(3rd Iteration)

General Category	Subcategory	Absolute Frequency	Relative Frequency (Percent)
Contract	Award	5	27.78
	Budgeting	4	22.22
	Contractor Capability	2	11.11
	Other	7	38.89
Total		18	100.00
Contract Cost		39	100.00
Total		39	100.00
Contract Flexibility		40	100.00
Total		40	100.00
Skills		29	100.00
Total		29	100.00

Table 6 (Continued)

General Category	Subcategory	Absolute Frequency	Relative Frequency (Percent)
Simulator Operations	Facility Upkeep	6	13.33
	Support Equipment	3	6.67
	Configuration Control	8	17.78
	Technical Data	7	15.55
	Security	4	8.89
	Quality Control	2	4.44
	System Complexity	5	11.11
	Operators	3	6.67
	Operating Environment	3	6.67
	Other	4	8.89
Total		45	100.00
Schedule Flexibility		24	100.00
Total		24	100.00
Simulator Availability		38	100.00
Total		38	100.00

Table 6 (Continued)

General Category	Subcategory	Absolute Frequency	Relative Frequency (Percent)
Manpower	Cost	6	10.53
	Formal Training	16	28.07
	Mobilization	3	5.26
	Turnover of Personnel	15	26.32
	Flexibility	10	17.54
	Overseas Imbalance	4	7.02
	Other	3	5.26
Total		57	100.00
Acquisition of Personnel		22	100.00
Total		22	100.00
Supplies	Responsibility	11	44.00
	Pipeline Flow	8	32.00
	Cost	4	16.00
	Other	2	8.00
Total		25	100.00
Grand Total		337	100.00

Table 7

General Category Relative Frequency Distribution
(4th Iteration)

General Category	Absolute Frequency	Relative Frequency (Percent)
Contract	13	3.86
Contract Award	5	1.48
Contract Cost	39	11.57
Contract Flexibility	40	11.87
Skills	29	8.61
Simulator Operations	45	13.35
Schedule Flexibility	24	7.12
Simulator Availability	38	11.28
Manpower	57	16.91
Acquisition of Personnel	22	6.53
Supplies	25	7.42
Total	337	100.00

test (criterion test 1) and therefore was placed again under the general category "Contract." Since "Award" was the only subcategory eligible under the criterion test 4 to be removed as a general category and it proved insiginificant, then the indication was that all iterations were complete. The only step remaining was to apply the five percent significance test of the respective general categories to the subcategories (criterion test 3).

As shown in Table 6, the only subcategory to prove insignificant within its respective general category was "Quality Control." As a result of having a relative frequency less than five percent, the data items contained in "Quality Control" were placed in the "Other" subcategory.

As a result of completing all the criteria testing on the data, a final listing of relevant decision making factors was obtained and is presented in Table 8. The final listing for the specific subcategories is presented in Table 9.

Findings

The use of semantic content analysis did permit an identification of relevant decision making factors.

Table 8

General Category Relative Frequency Distribution
(Final)

General Category	Absolute Frequency	Relative Frequency (Percent)
Contract	18	5.24
Contract Cost	39	11.57
Contract Flexibility	40	11.87
Skills	29	8.61
Simulator Operations	45	13.35
Schedule Flexibility	24	7.12
Simulator Availability	38	11.28
Manpower	57	16.91
Acquisition of Personnel	22	6.53
Supplies	25	7.42
Total	337	100.00

Table 9

Subcategory Relative Frequency Distribution
(Final)

General Category	Subcategory	Absolute Frequency	Relative Frequency (Percent)
Contract	Award	5	27.78
	Budgeting	4	22.22
	Contractor Capability	2	11.11
	Other	7	38.89
Total		18	100.00
Contract Cost		39	100.00
Total		39	100.00
Contract Flexibility		40	100.00
Total		40	100.00
Skills		29	100.00
Total		29	100.00

Table 9 (Continued)

General Category	Subcategory	Absolute Frequency	Relative Frequency (Percent)
Simulator Operations	Facility Upkeep	6	13.33
	Support Equipment	3	6.67
	Configuration Control	8	17.78
	Technical Data	7	15.55
	Security	4	8.89
	System Complexity	5	11.11
	Operators	3	6.67
	Operating Equipment	3	6.67
	Other	6	13.33
Total		45	100.00
Schedule Flexibility		24	100.00
Total		24	100.00
Simulator Availability		38	100.00
Total		38	100.00

Table 9 (Continued)

General Category	Subcategory	Absolute Frequency	Relative Frequency (Percent)
Manpower	Cost	6	10.53
	Formal Training	16	28.07
	Mobilization	3	5.26
	Turnover of Personnel	15	26.32
	Flexibility	10	17.54
	Overseas Imbalance	4	7.02
	Other	3	5.26
Total		57	100.00
Acquisition of Personnel		22	100.00
Total		22	100.00
Supplies	Responsibility	11	44.00
	Pipeline Flow	8	32.00
	Cost	4	16.00
	Other	2	8.00
Total		25	100.00
Grand Total		337	100.00

The four general categories of "Contract," "Simulator Operations," "Manpower," and "Supplies" that were established a priori all withstood the criterion test applied for a test of significance. These four general categories remained during each successive iteration while new general categories were added or deleted during successive iterations until the final listing was obtained, Table 8, page 65.

The subcategories established a priori within each respective general category likewise withstood the appropriate criterion test with six subcategories eventually being raised to the level of general category. Within the original general category of "Contract," the subcategories of "Cost," "Flexibility," and "Skills" all qualified for general categorization. Under the general category of "Simulator Operations," the subcategories of "Schedule Flexibility" and "Simulator Availability" met the general categorization requirement. The general category of "Manpower" had only one subcategory to be upgraded, that of "Acquisition of Personnel." In the general category of "Supplies" no subcategory was able to withstand the general categorization test of significance. The addition of the six newly created general categories

brought the general category listing to ten. They were:

1. Contract
2. Contract Cost
3. Contract Flexibility
4. Skills
5. Simulator Operations
6. Schedule Flexibility
7. Simulator Availability
8. Manpower
9. Acquisition of Personnel
10. Supplies

After the data were initially coded an analysis into the subcategories of "Other" was accomplished to determine if any new subcategories could be established. The findings from this analysis were that nine new subcategories could be established because of applying criterion test 2. The new subcategories that were established within the respective general categories are listed below.

General Category	Subcategory
Contract	Award
	Budgeting
	Contractor Capability
Simulator Operations	Security
	Quality Control
	System Complexity
	Operators
	Operating Environment
Manpower	Overseas Imbalance

During the successive iterations the only new subcategory that was considered for general categorization was "Award." In the last iteration "Award" failed to comprise five percent of the total relative frequency distribution and was reclassified as a subcategory of

"Contract." Also, during the final iterative process, criterion test 3 was applied to the subcategories and only one, "Quality Control," failed the five percent significance test, therefore, its data items were included into the subcategory of "Other" for the final subcategory listing. As a result, of the nine subcategories established, eight remained after the final iteration.

After the final iteration was accomplished and the listing for general and subcategories was finalized, a reevaluation of the data items which comprised "Other", a subcategory of "Contract" was made since it had 38.89 percent of the items remaining within "Contract." It was reaffirmed that no coded items in this subcategory could be linked to a specific subcategory of "Contract" or qualified for creation of a new subcategory. The subcategories of "Other" for "Simulator Operations," "Manpower" and "Supplies" were not greater than 25 percent of their respective category and a further detailed evaluation of its component parts was not considered meaningful.

In summary, a total of ten factors appear to be significant under the established criteria tests. The findings show the percentile range of the factors to be

from 5.24 for "Contract" to 16.91 for "Manpower" with the balance of the factors within these two extremes. Figure 3 (Relative Frequency Distributions) presents a graphic portrayal of the findings for the general categories and Figure 4 (Relevant Decision Making Factors) provides a final listing of the relevant decision making factors. It is this final listing of factors that provided the basis upon which the conclusions and recommendations were made in Chapter 4.

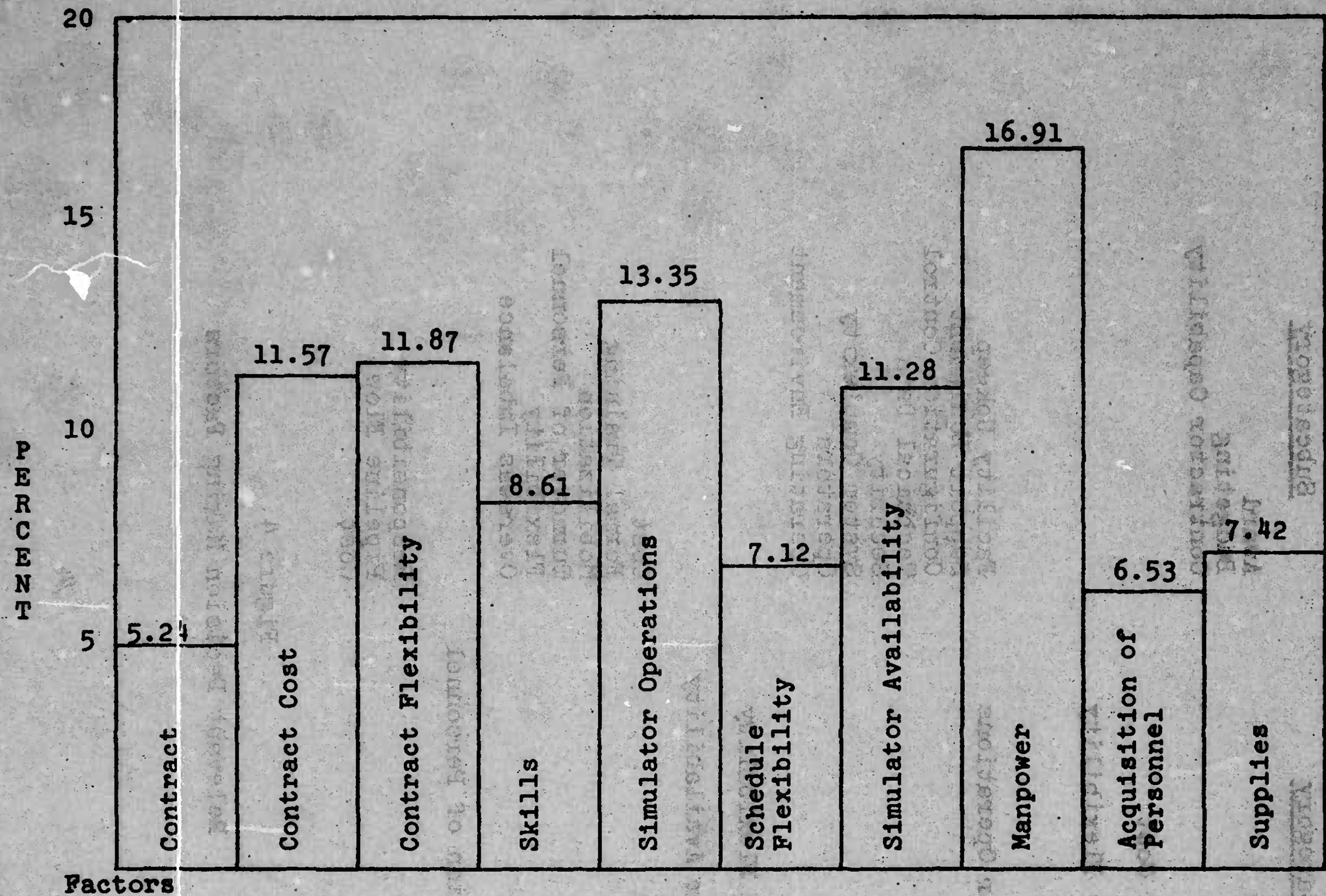

Figure 3

Relative Frequency Distributions

Category	Subcategory
Contract	Award
	Budgeting
	Contractor Capability
Contract Cost	
Contract Flexibility	
Skills	
Simulator Operations	Facility Upkeep
	Support Equipment
	Configuration Control
	Technical Data
	Security
	System Complexity
	Operators
	Operating Environment
Schedule Flexibility	
Simulator Availability	
Manpower	Cost
	Formal Training
	Mobilization
	Turnover of Personnel
	Flexibility
	Overseas Imbalance
Acquisition of Personnel	
Supplies	Responsibility
	Pipeline Flow
	Cost

Figure 4

Relevant Decision Making Factors

Chapter 4

CONCLUSIONS AND RECOMMENDATIONS

Overview

This chapter presents conclusions drawn from the findings in the data analysis along with corollary findings and associated conclusions collected throughout the research process. In addition to the conclusions, recommendations on two possible uses for the relevant factors identified and recommendations for future research efforts are included. The conclusions of this research are based solely upon the results of the data producing sample (Appendix D) and the assumptions presented in this chapter. The recommendations, while based upon the results of the research itself, were derived through the impressions of the researchers on areas they felt potential existed for future improvements and applications. The corollary findings and conclusions, while not derived through the basic research methodology, are based upon observations, responses, and impressions obtained by the researchers while conducting the open-end interviews and numerous contacts with flight simulator operations and

maintenance. These findings are based upon the researcher's perceptions of the current feelings about contract support of simulator maintenance.

Summary of Assumptions

1. Adequate data were gathered in open-end interviews to determine the relevant factors of consideration for the contract maintenance decision for flight simulators.

2. The data gathered through the literature search and open-end interviews generally reflect the views of the Air Force maintenance and management personnel sampled on relevant factors to be considered in addressing contract maintenance of flight simulators.

3. Factors other than cost are relevant considerations in determining whether or not to contract for maintenance.

4. The samples taken were adequate to determine the relevant factors of consideration for contract maintenance.

Summary of Limitations

1. The interview sampling plan was limited by time constraints and limited funds for travel.

2. The problems with the interpretive ability of the researchers affected the reliability of the open-end interview analysis.

3. With extremely limited Air Force experience in contract maintenance of flight simulators, the current views of Air Force personnel on relevant factors are highly opinionated without the backing of operational experience.

4. Findings of the research cannot be generalized outside the sample of Air Force flight simulator maintenance and management personnel used for the research.

5. As a consequence of the researchers TDY time constraints at each base, the responses to the open-end interview question were restricted in the time available to answer the question.

Conclusions

The objective of this research effort was to identify relevant factors for Air Force managers to consider when addressing the issue of whether to contract for maintenance or retain an organic maintenance capability at the organizational and intermediate level on Air Force flight simulators. The identification of relevant factors was achieved through the use of

semantic content analysis. The use of these factors which can be considered as "cost drivers" should assist maintenance managers at all levels in making a realistic assessment of the contract maintenance question and enabling tradeoffs to be made between decision variables until an acceptable solution is reached. The factors that have been identified are the result of only 54 open-end interviews and should not be generalized to the Air Force as a whole. Additionally, these factors should not be construed as the only factors that need to be considered when faced with the contract maintenance decision. Since no relative weight scheme was developed, only conjecture can be applied as to which is the "most important" or which is the "least." Figure 5, Comparison of Current OMB Exceptions with Identified Factors, does provide a means of assessing the relative importance of the identified decision making factors as perceived strictly through a look at the frequencies. The OMB Circular A-76 exceptions do not carry any weighting as to their relative importance. Additionally, these exceptions are broad in scope and deal with contract maintenance on a grand scale as opposed to the specificity of the identified decision making factors. While there is overlapping

OMB Circular A-76 Exceptions:

(1) Procurement of a product or service from a commercial source would disrupt or delay an agency's program.

(2) The government must operate an industrial activity for purposes of combat support, for retraining of military personnel, or to maintain or strengthen mobilization readiness.

(3) A satisfactory commercial source is not available and cannot be developed in time to provide a product or service when it is needed.

(4) The product or service is available from another Federal agency.

(5) Procurement of a product or service from a commercial source will result in a higher cost to the government [12].

Identified Relevant Decision Making Factors:

	Factor	Relative Frequency
(1)	Manpower	16.91
(2)	Simulator Operations	13.35
(3)	Contract Flexibility	11.87
(4)	Contract Cost	11.57
(5)	Simulator Availability	11.28
(6)	Skills	8.61
(7)	Supplies	7.42
(8)	Schedule Flexibility	7.12
(9)	Acquisition of Personnel	6.53
(10)	Contract	5.24

Figure 5

Comparison of Current OMB Exceptions With Identified Factors

between the exceptions and decision making factors, the latter are tailored more to the specific case of simulator maintenance and could possibly better handle problems inherent in simulator maintenance operations.

The importance of this research was in that a contribution was made to the body of knowledge. Relevant decision making factors are now available upon which managers can build some type of decision making apparatus to facilitate future decision making processes.

Corollary Findings and Conclusions

While conducting the open-end interviews, certain feelings were perceived during the discussions which were not reported but perhaps worthy of some future consideration. The personnel at the bases visited were for the most part extremely cooperative and willing to help. The ATD branch chiefs were extremely proud of their respective facilities and demonstrated a high degree of professionalism in taking as objective a view of the subject as possible. A point that should be recognized is that the maintenance personnel interviewed were Air Force "blue suiters." This coupled with the fact that they were participating in a research area which is

sensitive and could be perceived as having the potential of eliminating their career field, could have had a profound impact upon their responses.

A definite awareness was perceived among senior non-commissioned officers (NCO) interviewed on matters relating to simulation. They were clearly attuned to the contemporary issues facing the ATD branches at the unit level. A definite interest existed concerning the Air Force programs to modernize flight simulation systems and in advanced simulation techniques in general.

As the NCOs were up-to-date on contemporary issues, the contract maintenance question was no exception. While no valence (positive or negative) was assigned to the factors through the coding schematic, the interview responses for the majority of personnel appeared to reflect a negative view toward contractual services. This can partially be attributed to the fear of possible elimination of their career field and an infringement into their "unique" area of expertise. In support of this contention, the researchers perceived a strong feeling of professionalism and pride to exist among the military technicians.

While this research did not address which method (contract or organic) was most advantageous, a perceived

general impression exists which favored organic maintenance. The issue of using contract maintenance generated some negative comments during the research effort and some personnel were reluctant to discuss the issue, especially from a justification of organic maintenance standpoint. Some advocated having the burden of justification placed on the contractor to show how the contractor can do the job superior to the "blue suiter." Additionally, some resistance was found with senior Air Force managers due to the highly emotional nature of the subject and the fear of resulting adverse reactions. Also, during the data collection phase, several instances occurred when individuals approached on the subject, were quick to highlight failures from previous contract maintenance attempts, ignoring any known successful contract maintenance efforts. These are just a few examples of apparent sentiments that exist. With such strong sentiments existing, it will be difficult for the Air Force to objectively decide on which method will minimize cost and maximize effectiveness.

Aside from the areas of pride, professionalism, and negatism toward contract maintenance, discussion with maintenance personnel also indicated that the issue

The addition of the six newly created general categories

of contract maintenance on flight simulators has come up in a cyclic fashion. Along this line perhaps the Air Force needs to make a decision once and for all on what the maintenance concept should be. This option, however, is not in consonance with the current Air Force management policy of deciding on a case-by-case basis as to what the maintenance concept will be (37).

Recommendations

While the object of this research was to identify relevant decision making factors there is more that can be done in facilitating the decision making process. The development of these factors was only the first step toward resolving a manager's dilemma as to the proper decision to make. The factors as they stand alone do not provide the functional tool necessary to meet a manager's needs. It will be necessary for decision makers to take these factors and develop some type of decision making apparatus. There are many ways in which these factors could be utilized, however, the researchers feel that there are two strong possibilities that stand out among others. The first possibility is that a "decision tree" could possibly be developed similar to the AFLC "decision

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AN ASSESSMENT OF RELEVANT DECISION MAKING FACTORS FOR ORGANIC V--ETC(U)
SEP 77 R J ARCENEAUX, G E FARSCHMAN

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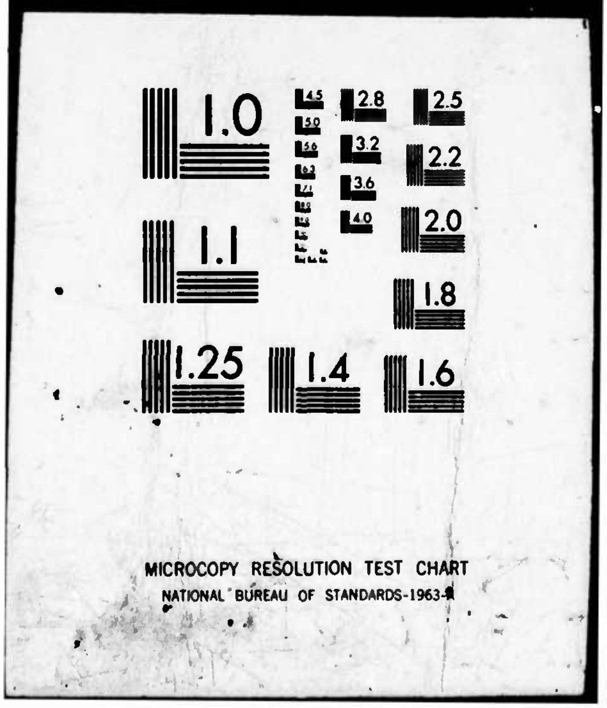
1.0
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1.25
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3.6
4.0
4.5
5.0
5.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

tree" regarding depot maintenance (Figure 7, Appendix C). This could be done by utilizing the relevant factors as a basic skeleton. The second possibility is to utilize the factors to further clarify and definitize the areas to be addressed when attempting to justify organic maintenance under the exceptions provided in OMB Circular A-76.

The first method will be demonstrated utilizing the "decision tree" network depicted in Figure 6. Since no weighting was developed for the factors, the "decision tree" was constructed for illustrative purposes, utilizing rigorous subjectivity. In attempting to analyze a decision, a manager could, if provided a "decision tree," systematically make tradeoffs between certain factors to arrive at an acceptable solution.

In using the "decision tree" presented in Figure 6, a manager starts with an evaluation of the preferred method (contract or organic) considering the factor "Manpower." All subcategories under "Manpower" would have to be addressed to determine where the favorable outcome lies. For example, the subcategory "Cost" should be addressed since flight simulator maintenance has been alluded to as manpower intensive (27) and, therefore, cost

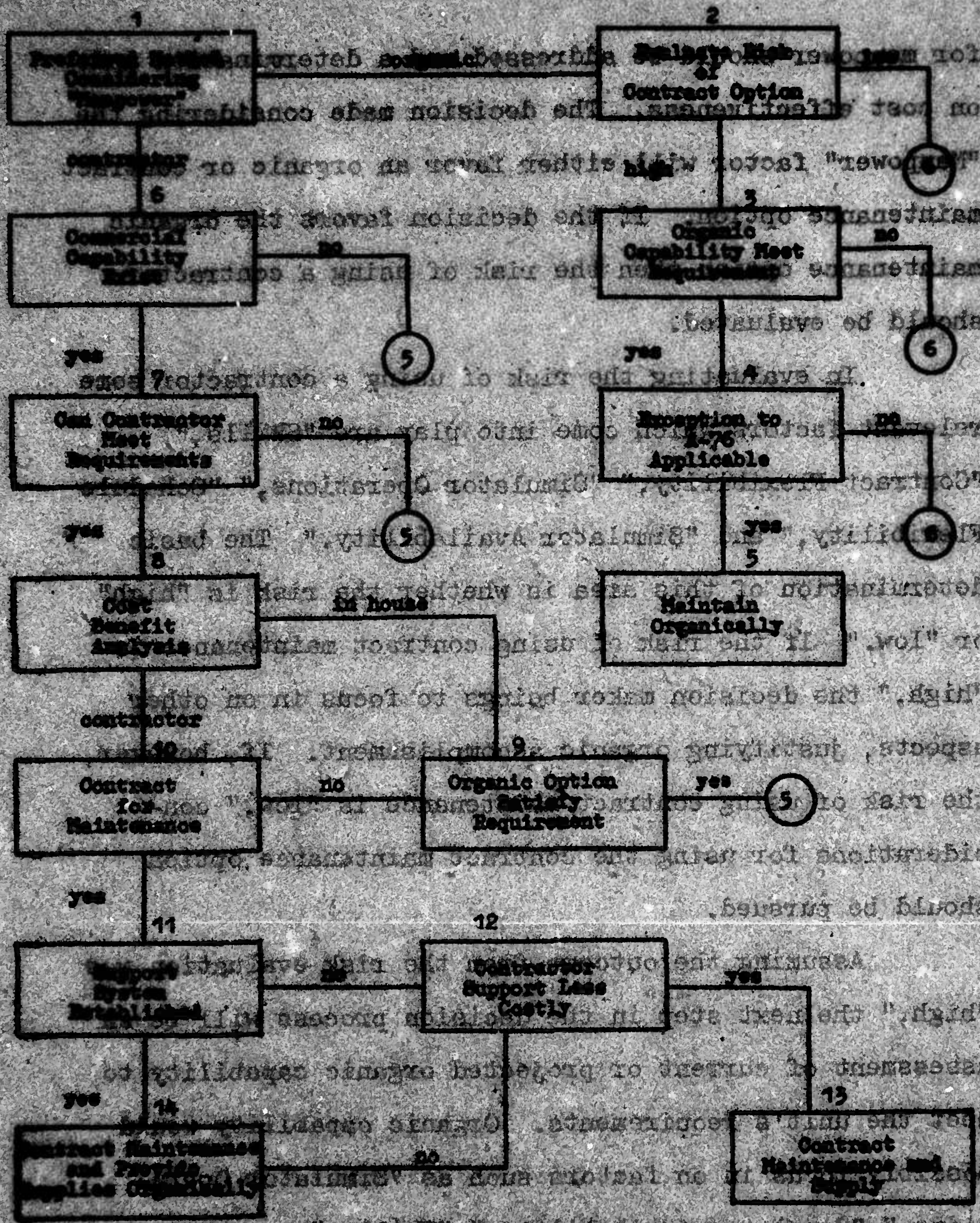


Figure 6

Contract Maintenance Decision Tree

for manpower should be addressed and a determination made on cost effectiveness. The decision made considering the "Manpower" factor will either favor an organic or contract maintenance option. If the decision favors the organic maintenance option then the risk of using a contractor should be evaluated.

In evaluating the risk of using a contractor some relevant factors which come into play are "Skills," "Contract Flexibility," "Simulator Operations," "Schedule Flexibility," and "Simulator Availability." The basic determination of this area is whether the risk is "high" or "low." If the risk of using contract maintenance is "high," the decision maker beings to focus in on other aspects, justifying organic accomplishment. If, however, the risk of using contract maintenance is "low," considerations for using the contract maintenance option should be pursued.

Assuming the outcome from the risk evaluation was "high," the next step in the decision process will be an assessment of current or projected organic capability to meet the unit's requirements. Organic capability would possibly focus in on factors such as "Simulator Operations," "Simulator Availability," "Skills,"

"Schedule Availability," and "Supplies." If the determination is "yes," then the present or projected organic capability can meet the units requirements and if "no", then it cannot. If the answer is "yes" then an appropriate exception criterion of OMB Circular A-76 for not utilizing the private sector must be justified and if justified then the intuitive outcome would be to maintain the flight simulator organically.

Now, assuming that the risk of using a contractor was "low," then the decision maker should determine if commercial capability exists and is available. "Contractors Capability," "Acquisition of Personnel," and "Skills" are some of the relevant factors which lend themselves to resolving the question of commercial capability. The basic determinations will be either "yes," commercial capability exists, or "no," it does not exist. If commercial capability does not exist, then the decision should revert to organic maintenance.

Once commercial capability has been determined to exist then an evaluation of the contractor's ability to meet and provide the unit's requirements should be addressed. To assist the decision maker, relevant factors such as "Contract Flexibility," "Contract,"

"Simulator Operations," and "Simulator Availability" are considered appropriate. If the answer to this step is "yes," then consideration of the cost effectiveness should be addressed in determining whether the contract maintenance option is economically beneficial. If, however, the answer is "no" to the question of the contractor's ability to meet the unit's requirements, then the decision should revert to organic maintenance.

When evaluating the cost effectiveness of each maintenance option, several categories appear appropriate with "Contract Cost" being the most prevalent factor. The determination here is on which maintenance option is the more economical. If the organic option is more economical, but the organic option cannot satisfy the unit's requirements, then the outcome would be the same as if the contract maintenance option had been more economical.

After the decision to use contract maintenance is made, an evaluation of the support system should be made. The relevant factor of "Supplies" can be used during this evaluation. If the system is established, then supplies should be provided organically and only the maintenance being contracted. However, if a support

system has been established, then the question which has to be addressed is "who can provide the supplies at a lesser cost?" The answer to this question on lesser cost will determine if the decision will be to contract for maintenance and supplies or just for maintenance.

As shown in this simplified example, this may be a viable method in which the relevant decision making factors could further be developed into a usable management tool.

Another method of possibly utilizing the decision making factors could be in further definitizing the areas to be addressed within the five specific exceptions to the basic OMB policy on utilization of the private sector. In this method, only those factors and relevant subcategories that are applicable to the specific exception to OMB Circular A-76 would be analyzed.

A possible classification of decision making factors within each of the five exceptions are shown below. While the factors chosen for each exception are open to interpretation, this is based on the opinions of the authors and reclassification may become necessary by the responsible manager in the decision making process.

Manpower

Funding

Contractor Capability

Contract Flexibility

Skills

Simulator Operations

Support Equipment

System Complexity

Simulator Schedule Flexibility

Simulator Availability

Supplies

Responsibility

Pipeline

[illegible] It is necessary for the Government to conduct a commercial or industrial activity for purposes of combat support or individual and unit retraining of military personnel or to maintain or strengthen mobilization readiness [42].

[illegible] A satisfactory commercial source is not available and cannot be developed in time to provide a product or service when it is needed [42].

Contracts

Contractor Capability

Skills

Acquisition of Personnel

d. The product or service is available from another Federal agency [12].

e. Procurement of the product or service from a commercial source will result in higher cost to the Government [12].

Contract Cost

Simulator Availability

Manpower

- Cost
- Formal Training

Acquisition of Personnel

Supplies

- Cost

In this classification it should be noted that decision making factors were not listed under exceptions b and d. This was due to two reasons: First, exception b was interpreted to apply to depot level maintenance which was not within the scope of the research. Second, exception d contained no factors since it dealt with other Federal agencies and this research only dealt with Air Force organic maintenance versus contract maintenance.

Utilizing this method would enable a manager attempting to justify maintaining an organic maintenance capability to look into the detailed aspects relating to the applicable exception. An example of how these factors

could be applied can be shown using the first exception to OMB Circular A-76. Under this exception certain aspects of seven general factors were felt to have relevance.

Under the "Contract" general category, items such as the awarding of the contract, possible funding problems, and the capability of the prospective contractors to do the required simulator maintenance at acceptable levels could possibly disrupt or materially delay simulator operations. If justification could be found within these specifics, then the program could possibly be justified to be conducted organically.

Along with the "Contract" general category, the area of "Contract Flexibility" should possibly be addressed. Union activities, strikes and problems relating to the control of the contractor could all be causes of disruptions and/or delays.

The next area of "Skills" should possibly be scrutinized closely when taking a long term systems approach to the decision. Here, definite problems in disruptions and delays could be encountered in the long run due to a contractor not renewing a contract. If the Air Force has lost or given up its organic capabilities then

the overall simulator program would be hampered until such a capability could again be achieved, which could take an excessive amount of time. In addition to the loss of skills, an additional disruption could possibly be caused by the overall loss of system knowledge due to corporate memory.

The next area to be addressed, "Simulator Operations," contains two specific areas that should possibly be analyzed. The first, "Support Equipment," should possibly be considered in relation to possible delays or disruptions caused by improper provisioning and/or maintaining of support and test equipment. Along with this, "System Complexity" could possibly cause problems if it is beyond the maintenance capability of either the Air Force or the contractor.

An analysis should possibly be made in the area of "Simulator Schedule Flexibility." In this area problems might erupt as far as the contractor providing services whenever the Air Force felt they had a need. There may be times when a last minute change in requirements would dictate some flexibility in scheduling of hours such as during a no notice inspection. Situations such as this could disrupt the Air Force's program if the contractor could not or would not respond.

Another area which could be of extreme importance is "Availability." If the contractor cannot provide the required availability then by definition there would be disruptions to the Air Force simulator training program. This could have far reaching effects in the areas of cost, aircrew proficiency, and aircraft scheduling.

A final area that might be addressed under this first exception is that of "Supplies." Within "Supplies" there are two specific areas that may need to be analyzed, "Responsibility" and "Pipeline Flow." These areas address problems which would result in relation to who provides the necessary spares and can the supply system respond in a satisfactory manner. These areas could have a profound affect on simulator availability which, in turn, could lead to disruptions.

Recommendations for Further Research

As was pointed out, the attempt at developing relevant decision making factors is only the first step at solving the dilemma of which decision should be made. Future research efforts would be fruitful in the area of expanding upon this study and developing a weighting of the factors and development of a possible "decision tree" model. Once this is accomplished, a validation of the

proposed model would leave decision makers with a valuable management tool in arriving at the "best" decision. Additionally, benefits could be gained through an analysis of the cost data collection system implemented by the Air Staff. Research as to the adequacy of the system along with possible cost analysis of various maintenance options could be of great value to managers faced with the contract maintenance decision.

Concluding Comment

This research effort began when the August 1976 revision of OMB Circular A-76 was impacting upon all government activities. These changes in personnel cost factors were an integral part of the justification for this research effort. A reversal to this trend appears to be in the making with a new revision to OMB Circular A-76. The personnel cost factors have been lowered from 24.7 percent to 14.1 percent (14:1). This might be indicative of a reversal in the emphasis on contracting out and a stronger role in maintaining an organic capability.

APPENDIX A

GLOSSARY OF ABBREVIATIONS

APPENDIX A

Abbreviation	Proper Nomenclature
AFLC	Air Force Logistics Command
AFSC	Air Force Systems Command
ALC	Air Logistics Center
AMS	Avionics Maintenance Squadron
ASD	Aeronautical Systems Division
ATC	Air Training Command
ATD	Aircrew Training Device
CSAF	Chief of Staff United States Air Force
DCM	Deputy Commander for Maintenance
DoD	Department of Defense
FY	Fiscal Year
GAO	General Accounting Office
HQ	Headquarters
MAC	Military Airlift Command
OMB	Office of Management and Budget
SAC	Strategic Air Command
SAG	Simulator Advisory Group
SIMSPO	Simulator System Program Office
TAC	Tactical Air Command
USAF	United States Air Force

APPENDIX B

WHITE PAPER ON FLIGHT SIMULATOR SUPPORT

APPENDIX B

"It's our habits that take us where we were yesterday, and it's our attitudes that keep us there."

Confucius

1. As the Air Force moves towards an era of significant increase in use of flight simulators for aircrew training, modification of existing policies and procedures should be considered. Much is already underway, like moving support responsibility in the operational commands from operations to maintenance and the detailed re-examination of whether or not present training programs are making maximum practical use of existing simulators. Acquisition techniques are being explored in search of better approaches for obtaining schedule and performance objectives at reduced costs. Faced with a lack of objective data to provide guidance on the relative training utility of various simulator features being requested (e.g., motion, wide-field-of-view visual systems, adaptive training features, etc.), ASD, the using commands, and the Air Force Human Resources Laboratory are working to make the best possible use of the information available now, and are pacing simulator investment programs carefully to provide for needed program adjustments as the work continues. An additional area that deserves major consideration is the type of support posture. This area interrelates very significantly with acquisition planning and, therefore, is driven by the need to arrive at certain decisions in order to structure the most useful contracts.

2. An examination of experience to date indicates that simulator support is highly manpower intensive. Some data shows support contracts with a ratio of 6:1 to 7:1 of personnel to material costs. There seems to be general agreement that these ratios are representative. This indicates that, to make major inroads into support costs, approaches that have a potential for reducing the maintenance manning are

required. Related is the fact that annually the Congress has imposed manpower reductions on the DOD. Therefore, support planning needs to consider not only cost but techniques to accommodate to the changing environment of the future.

3. Probably a more critical goal for finding the best support posture than reducing support costs in insuring high availability-for-training rates. Only if the using commands can depend upon aborting very few training periods should they agree to substituting simulator training for large amounts of flying hours.

4. The historical approach to reduced support costs and high in-commission rates has been to try to specify very high mean-time-between-failure (MTBF) rates and very low mean-time-to-repair (MTTR). Testing to determine contractual compliance has led to long series of negotiations on the "ground rules" with Government and contractor as antagonists. Two interrelated circumstances have made this a less than satisfactory situation: (1) The contractor has been motivated to achieve only the minimum level of performance necessary to comply with the contract; (2) The Government's ability to determine and specify the most cost-effective levels of MTBF and MTTR is marginal, at best. Further, often very expensive support equipment has been foisted onto the Air Force justified mainly by the Government-imposed MTTR.

5. For combat weapon systems, there is probably little alternative to the historical approach of blue-suit maintenance and the Air Force must continually try to learn how to do better. Occasionally, innovative concepts come along, such as reliability improvement warranties, that look attractive and, even after the initial glamour has worn off, do provide a meaningful degree of improvement.

6. Simulators are different, however. They certainly are not used to fight and only rarely will be located in a potential combat zone. If they are, they should not be in use during any active combat in that zone. This indicates they

are viable candidates for other than "blue-suit" maintenance. These considerations, along with the increased complexity of modern digital technology simulation and potentially marginal technical capacity of an all-volunteer force, argue strongly for consideration of the increased personnel stability that should be available through civil service or contractor maintenance. (In fact, the only attractive argument supporting continued "blue suit" simulator maintenance is the possibility that the individuals could be sufficiently cross-trained to be immediately available for the wartime surge capability needed in the tactical and airlift forces.) The Air Force is moving to contract and/or civil service maintenance in a number of areas. Command and control systems, the C-9 aircraft, and Air Training Command aircraft are current examples. The KC-135 and Advanced Tanker Cargo Aircraft are purportedly being actively considered as well. The non-combat nature and complexity of simulators certainly make them equally or more attractive candidates. Further, independent of the cost-effectiveness or stability considerations, the Congressional reductions referenced earlier could force saving the blue-suit portions for fighting jobs and contract for much of the rest.

7. [Omitted in source document]

8. The reason for this lengthy discussion is to prepare for the introduction of an acquisition technique that will help in getting beter availability and supportability in simulators while simultaneously establishing a sound posture for either organic or contract maintenance. However, the approach will require some significant adjustment of existing programming and budgeting policies as well as logistic support practices. The technique consists of obtaining fixed-price proposals for maintenance of the simulators simultaneously with the competitive proposals for simulator production. These would be options to the Government. Payment would be dependent on availability of the simulator for training with a rather severe penalty for lost training periods. By requiring the options

to cover several years, the contractor will find his profit margin as affected in a major way by the same things the Air Force is interested in—availability and support costs. Further, if these options cover four or five years in one year increments, considerable flexibility is obtained.

a. Contract maintenance can be observed for a couple of years and if organic maintenance seems best, the remaining time can be used for training and provisioning based on their experience; or

b. If continued contract maintenance looks attractive, data can be procured to obtain it competitively; or

c. A spares and support equipment kit can be provided by the Government initially that the contractor can use but must keep replenished; or

d. Full Government logistic support can be combined with contractor maintenance; or, etc., etc.

10. The key is that whichever alternative is selected, the contractor will be motivated during design and production to the Air Force's objectives—not just minimum compliance with reliability and maintainability specifications. In the final analysis, it is his inventiveness and ingenuity that are being procured and, therefore, keeping them with our objectives in the day-to-day design trade-off decisions is important.

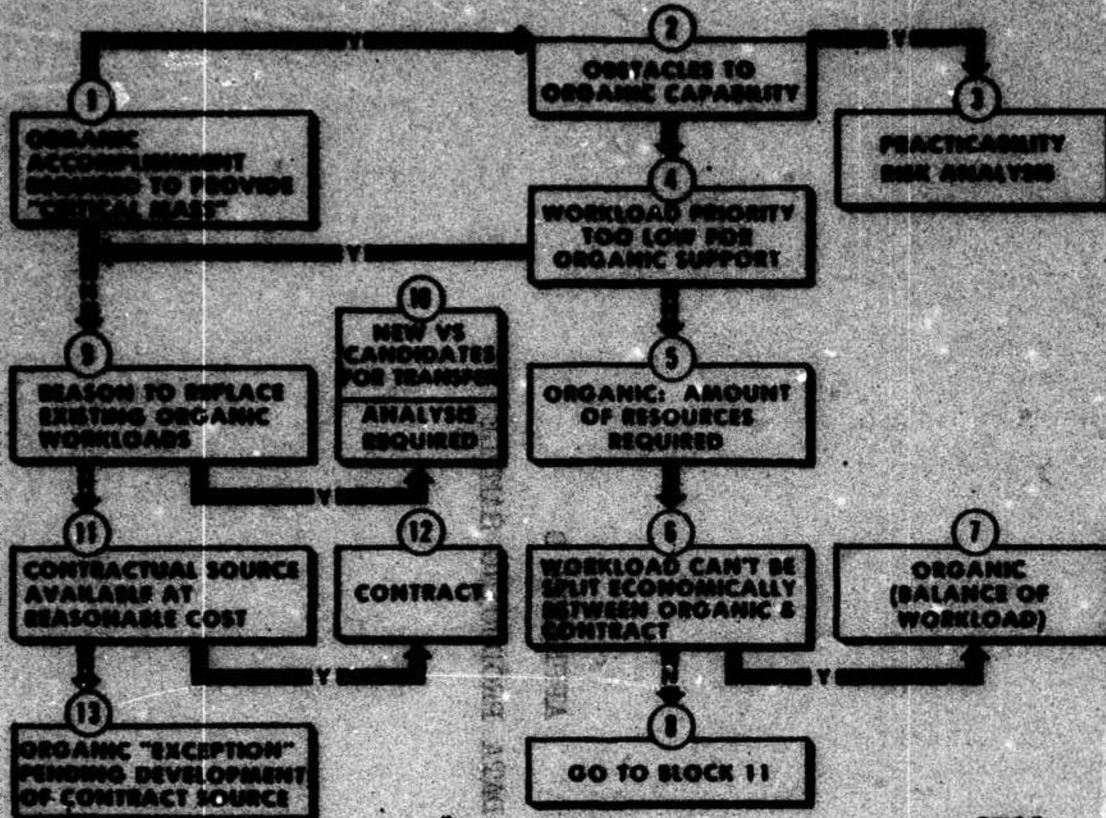
11. One basic problem in implementing this concept is with the DOD planning, programming, budgeting system. How can alternatives be kept open until experience shows the right course of action when the money for the various alternatives must be reserved in different pockets? Not only budgets, but manpower authorizations get entwined. Though these issues seem arcane at first glance, certainly they can yield to thoughtful deliberation if approached in a "can do" rather than "hand wringing" manner. It may, however, take recognition at the highest OSD policy-making levels that we are in a transitional phase. Some flexibility will be required

between manpower authorizations, spares and O&M budgets during the learning phase, and then resources must be switched quickly to the proper pocket. As experience is gained more stable long-range plans can be developed. The dollars and/or authorizations at issue are not really that great when considered in a broader context.

12. Two things are needed immediately. Some creative thought on the logistics aspects is needed so that the right kind of options can be structured during source selection on the simulators. The broader picture of how to handle the budgeting between AFLC and using commands and between user O&M budget and manpower authorizations also needs to be worked. It is important to get on with these quickly or else give up what could be a very significant tool in acquisition of better simulators with improved utility and reduced ownership costs [28].

APPENDIX C

DEPOT MAINTENANCE SOURCE OF REPAIR "DECISION TREE"



[39]

Figure 7

Depot Maintenance Decision Tree

APPENDIX D

DATA PRODUCING SAMPLE

APPENDIX D

I. Operating Locations

Unit	Type Simulators	Date Visited
12 Flying Training Wing (ATC) Randolph AFB TX	T-37/38	18 Mar 77
347 Tactical Fighter Wing (TAC) Moody AFB GA	F-4	18 Mar 77
7 Bombardment Wing (SAC) Carswell AFB TX	B-52/KC-135	21 Mar 77
354 Tactical Fighter Wing (TAC) Myrtle Beach AFB SC	A-7	21 Mar 77
64th Flying Training Wing (ATC) Reese AFB TX	T-37/38	22 Mar 77
443 Military Airlift Wing (MAC) Altus AFB OK	C-5/141	23 Mar 77
436 Military Airlift Wing (MAC) Dover AFB DEL	C-5	15 Apr 77
380 Bombardment Wing (SAC) Plattsburgh AFB NY	FB-111/KC135	15 Apr 77

II. Simulatory Advisory Group

Simulatory Advisory Group Meeting . . . . 26 Apr 77

APPENDIX E

QUESTION FOR OPEN-END INTERVIEW

APPENDIX E

In narrative form, please answer the following question. You can write as much as you like, preferably at least one page.

What, in your opinion, should be relevant factors for the Air Force to consider when addressing the question of whether or not to utilize contract maintenance for organizational and intermediate level maintenance of flight simulators?

Please do not concern yourself with questions involving interim contract support associated with new simulator acquisition/deployment.

APPENDIX F

DOCUMENTS USED FOR PILOT STUDY

APPENDIX F

1. Summary of Documents Used:

a. Letters 11

b. Minutes of Meetings 5

c. Staff Summary Sheets/Command/Term of Interest and Briefing 4

d. Study/Concept Paper 2

e. Air Force Messages 2

Total 24

2. Specific Listing:

a. Letters

(1) Contract Maintenance for Air Force Flight/Aircrew Simulators, From Lieutenant General John W. Roberts, Commander, ATC to HQ USAF/LG, 23 January 1976.

(2) Maintenance Options for Flight Simulators, From Brigadier General Benton K. Partin, Deputy for Systems, HQ ASD to AFLC/AQ, 11 June 1976.

(3) Maintenance of Flight Simulators, From Major General George H. Sylvester, Vice Commander ASD to AFSC/CV, 1 July 1976.

(4) Support of F-15 Simulator at Langley, From Lieutenant General James T. Stewart, Commander ASD to Lieutenant General Sanford K. Moats, Vice Commander TAC, 14 July 1976.

(5) Support Concept for Simulators, From Lieutenant Colonel Charles O. Coogan, Deputy for Readiness Development/AFALD to Simulator System Program Office/ASD, 13 August 1976.

(6) Maintenance of Flight Simulators, From Major General Garry M. Killpack, Vice Commander ATC to AFSC/CV, 20 August 1976.

(7) Maintenance of Flight Simulators, From Lieutenant General George Rhodes, Vice Commander AFLC to AFSC/CV, 23 August 1976.

(8) Maintenance of Flight Simulators, From Lieutenant General John R. Gonge, Vice Commander MAC to AFSC/CV, 30 August 1976.

(9) Maintenance of Flight Simulators, From Lieutenant General James M. Keck, Vice Commander SAC to Lieutenant General Robert T. Marsh, Vice Commander AFSC, 15 September 1976.

(10) Maintenance of Flight Simulators, From Lieutenant General Sanford K. Moats, Vice Commander TAC to AFSC/CV, 8 October 1976.

(11) Maintenance of Flight Simulators, From Major General Robert A. Rushworth, Vice Commander ASD to AFSC/CS, 24 November 1976.

b. Minutes of Meetings

(1) Minutes from Simulator Logistics Conference, Naval Training Equipment Center (NTEC), Orlando, Florida, 20-22 April 1976.

(2) Minutes of Simulator Advisory Group, Aeronautical Systems Division, Wright-Patterson AFB, Ohio, 30 July 1976.

(3) Minutes of Air Force Acquisition Logistics Division Simulator Maintenance Concept Meeting, Wright-Patterson AFB, Ohio, 21 September 1976.

(4) Minutes of Simulator Advisory Group, Aeronautical Systems Division, Wright-Patterson AFB, Ohio, 19 November 1976.

(5) Minutes of Simulator Logistics Support Meeting, HQ AFLC/LOW, Wright-Patterson AFB, Ohio, 27-28 October 1976.

c. <u>Staff Summary Sheet/Command Items of Interest/ Briefing</u>

(1) Air Training Command, Item of Interest, MAJCOM Aircrew Simulator Training Conference, Randolph AFB, Texas, 11 December 1975.

(2) Air Training Command, Staff Summary, Contract Maintenance Flight/Aircrew Simulators, Randolph AFB, Texas, 13 January 1976.

(3) Air Training Command, Item of Interest, Contract Maintenance for AF Flight/Aircrew Simulators, Randolph AFB, Texas, 15 March 1976.

(4) Briefing, Trend Towards Civilian Maintenance, Simulator Advisory Group Meeting, Wright-Patterson AFB, Ohio, 20-22 July 1976.

d. <u>Study and Concept Paper</u>

(1) Cost of Government Vs Contractor Maintenance of Training Devices, Ogden Air Logistics Center, Hill AFB, Utah, undated. Also referred to as the "Hill Study."

(2) White Paper on Flight Simulator Support, Simulator Systems Program Office, Wright-Patterson AFB, Ohio, undated.

e. <u>Messages</u>

(1) Logistics Support for Training Devices, From Directorate of Material Management, Hill AFB, Utah, to Simulator Systems Program Office, Wright-Patterson AFB, Ohio, 29 July 1976.

(2) Maintenance Concepts for Simulators, From Directorate of Material Management, Hill AFB, Utah to HQ AFLC, 21 September 1976.

APPENDIX G

RESULTS OF PILOT STUDY

APPENDIX G

Results of the Pilot Study

General Category	Subcategory	Absolute Frequency	Relative Frequency (Percent)
Contract	Cost	24	17.91
	Flexibility	0	0.0
	Skills	14	10.45
	Other	7	5.22
Total		45	33.58
Simulator Operations	Availability	19	14.18
	Facility Upkeep	0	0.0
	Schedule Flexibility	3	2.24
	Support Equipment	5	3.73
	Configuration Control	8	5.97
	Technical Data	3	2.24
	Other	3	2.24
Total		41	30.60
Manpower	Cost	9	6.72
	Acquisition of Personnel	10	7.46
	Formal Training	10	7.46
	Turnover of Personnel	5	3.73
	Mobilization	4	2.98
	Flexibility	0	0.0
	Other	1	.72
Total		39	29.1

APPENDIX C (Continued)

General Category	Subcategory	Absolute Frequency	Relative Frequency (Percent)
[illegible]	Responsibility	5	[illegible]
	Pipeline Flow	2	[illegible]
	Cost	0	[illegible]
	Other	2	[illegible]
Total		9	[illegible]

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